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(71) Applicant: **POLITECNICO DI MILANO** [IT/IT]; Piazza Leonardo da Vinci 32, 20133 Milan (IT).

(72) Inventors: **MURANO, Francesco**; c/o Politecnico di Milano, Via Durando, 38a, 20158 Milan (IT). **CELI, Manuela**; c/o Politecnico di Milano, Via Durando, 38a, 20158 Milan (IT).

(74) Agent: **GIRLANDO, Mario** et al.; c/o Perani & Partners, Piazza Armando Diaz 7, 20123 Milan (IT).

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(54) Title: APPARATUS AND METHOD FOR ILLUMINATING OBJECTS

(57) Abstract: An apparatus (1) for illuminating items comprises a the imaging device (2) for capturing an image of an area (A), and generating a first signal (EVI) representative of the captured image; a processing unit (3) which is configured to: receive a first signal (EVI), process it through an image recognition and edge detection algorithm to identify one or more shapes (F) delimited by edges (B), the processing unit (3) being further configured to process the captured image by applying a first color inside the edge (B) of each shape (F) and a second color outside the edge (B) of each shape (F), and generate a second signal (EL) representative of the processed image; the apparatus (1) further comprises an image projection device (4), which is configured to receive the second signal (EL), generate a light beam representative of the processed image and direct the light beam to the area (A).

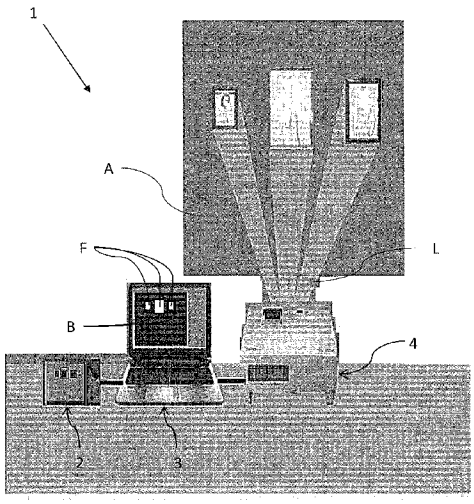

Fig. 1

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Title: "Apparatus and method for illuminating objects"

DESCRIPTION

Field of The Invention

The present invention relates to an apparatus and a method for illuminating objects. The present invention finds particular application in the illumination of art exhibitions, museums and works in general.

Discussion of the related art

Prior art illumination systems are composed of pluralities of light sources arranged in a predetermined position and with a predetermined orientation according to the position, shape and size of the objects to be illuminated.

A first example of a known illumination system is disclosed in CN203259184U. This document discloses a smart monitoring and illuminating system, comprising a digital video camera which is designed to capture images of a real-time environment and an illuminating controller that provides an on/off control on an illuminating lamp. Particularly, the system is used to monitor accesses to an environment through a door that can be opened or closed, thereby modifying the image captured by the camera and accordingly cause the lamp to be turned on and off.

A second example of a known illumination system is disclosed in KR20130122317. This document discloses an illumination system that comprises a security video camera which captures images of a zone to be monitored and an illumination controller that can move an image projection devices in response to the movements of the objects being filmed by the camera.

The above discussed systems can control the actuation and movement of an image projection devices according to the images that are being captured by a video

camera. Nevertheless, they are not able to illuminate the monitored area according to the fixed or moving objects located therein, their shape and/or distance, as the illumination configuration is predetermined and can only be manually changed.

This problem is particularly relevant in art exhibition illumination systems, whose spotlights are manually moved by illumination operators according to the position, size of the works and of the information totems on the walls.

Whenever a work is removed or replaced with another work, the operators are required to change the configuration of the illumination systems to adjust work illumination to prevent illumination of areas in which no work is present, as it often occurs.

Therefore, there is generally the need to be able to automatically adjust the configuration of the illumination devices in response to changes concerning the presence, position and size of the objects arranged in an area designed to be illuminated by said illumination devices.

Summary of The Invention

One object of the present invention is to provide an apparatus and a method for illuminating objects that can automatically adapt the illumination configuration according to the objects that are to be actually illuminated by the illumination device.

This and other objects are achieved by a system or a method for supplying a railroad path as claimed in any of the appended claims.

A first embodiment of the invention comprises an apparatus for illuminating objects arranged in an area.

The apparatus comprises an imaging device configured to capture an image of the area and generate a first signal representative of the captured image.

A processing unit is in signal communication with the imaging device and is configured to receive the first signal. Thus, the first signal is processed by an image recognition and edge detection algorithm to identify one or more shapes delimited by edges, in the image that has been captured.

The processing unit processes the captured image by applying a first color inside the edge of each identified shape and a second color outside the edge of each identified shape. The processing unit generates a second signal representative of the processed image.

The apparatus further comprises an image projection device, in signal communication with the processing unit and configured to receive the second signals and generate a light beam representative of the processed image. Then, the image projection device directs the light beam to the area.

A second embodiment of the invention comprises a method for illuminating objects arranged in an area. This method comprises a step of capturing an image of the area.

The image is processed using an image recognition and edge detection algorithm to identify one or more shapes bounded by edges.

A first color is applied inside the edge of each identified shape. Similarly, a second color is applied outside the edges of the identified shapes.

Then, a light beam representative of the processed image is generated. Such beam is directed to the area to be illuminated.

The invention solves the above discussed technical problem. Both to the apparatus and method of the invention are able to recognize the areas with objects to be illuminated, such as paintings, and to identify their shapes on a captured image. The use of an image projection devices can clearly illuminate only these zones.

Furthermore, advantageously, the apparatus and the method of the invention are able to easily adapt the illumination to the changing arrangement of the objects to be illuminated. For this, the above described procedure will be simply repeated, with no part having to be physically displaced.

BRIEF DESCRIPTION OF THE DRAWINGS

The characteristics and advantages of the present invention will result from the following detailed description of a possible embodiment, illustrated as a non-limiting example in the annexed drawings, in which:

- Figure 1 shows a schematic view of an apparatus for illuminating objects according to the present invention; and
- Figure 2 shows a block diagram which illustrates the operation of the apparatus of Figure 1.

DETAILED DESCRIPTION

Referring to the annexed figures, numeral 1 generally designates an apparatus for illuminating objects arranged in an area according to the present invention.

The apparatus 1 comprises an imaging device 2. Such an imaging device 2 is configured to capture an image of an area "A" and generate a first signal "IM" representative of the captured image. By mere way of example, the imaging device 2 may be a dedicated camera, a web cam or a smartphone having a camera incorporated therein.

The apparatus 1 also comprises a processing unit 3. Such processing unit 3 is particularly put in signal communication with the imaging device 2. Furthermore, the processing unit 3 is designed to receive the above mentioned first signal "IM". The

processing unit 3 analyzes the first signal "IM", processes it and outputs a second signal "EL" representative of a processed image. Further details on the architecture and operation of the processing unit 3 will be provided hereinbelow.

The apparatus 1 further comprises an image projection device 4, which is in signal communication with the processing unit 3. Particularly, the image projection devices 4 is configured to receive the aforementioned second signal "EL", which encodes the image processed by the processing unit, and projects it on the area "A". For example, the image projection devices may be a commercially available video projector.

Particularly referring to Figure 2, the operation of the processing unit 3 of the present invention will be now described in further detail. For completeness and ease of description, the processing unit 3 will be described by dividing it into a plurality of functional modules. Nevertheless, this shall in no way be construed as a limitation to the to the structure of the processing unit 3. The processing unit 3 may have any type of structure suitable for the purpose sch as, by way of example only, one or more dedicated hardware devices, one or more software libraries or applications, one or more virtual machines or any combination of these elements or others. The various parts that form the processing unit 3 may be all implemented on a single platform or may be distributed across multiple hardware components connected together by wired or wireless connection, through n a local area network, via the Internet or a virtual private network or any combination of such connections and others.

The processing unit 3 comprises an acquisition module 5, which is directly connected to the imaging device 2, and detects the transmission of the aforementioned first signal "IM".

The processing unit 3 comprises a recognition module 6, which is adapted to

process the first signal "IM" using an image recognition and edge detection algorithm. In the preferred embodiment of the invention, the recognition module 6 implements the Canny algorithm, substantially as described in "*J. F. Canny - a computational approach to edge detection - IEEE Transactions on Pattern Analysis and Machine Intelligence, p. 679-698, 1986*". By this arrangement, one or more closed shapes "F", i.e. completely delimited by closed edges, are identified in the captured image. Particularly, the processing unit 3 has such purpose.

Optionally, the processing unit 3 is configured to process the first signal "IM" to detect the texture of the zones inside the edges "B" of the identified shapes "F". This operation is particularly carried out by the recognition module 4. Advantageously, this information allows detection of the type of surface enclosed by the edge "B" (for example, in case of a painting, such detection will determine whether it is an oil on canvas). This information may be incorporated in the second signal "EL", which will also include information representative of the texture that has been detected.

The processing unit 3 also comprises a control module 7, which completes the image processing operation. Particularly, the control module 7 is designed to apply a first color inside the edge "B" of each previously identified shape "F". Similarly, a second color is applied outside the edges "B" of the shapes "F", i.e. on the side of the image outside the shapes "F". Namely, the shapes "F" are uniformly filled with the first color, whereas the external parts are uniformly filled with the second color. Thus, the processed image will only have two colors, i.e. is the first and the second color.

In the preferred embodiment of the invention, the first color is white and the second color is black. In alternative embodiments of the invention, the first and second colors may be any color as long as a good contrast is ensured therebetween. Thus, the processed image is encoded in the aforementioned second signal "EL".

Particularly referring to Figure 1, it shall be noted that the image projection devices 4 is designed to generate a light beam "L" representative of the processed image. Thus, such light beam “L” is directed to the area “A” to illuminate the previously detected objects.

According to the invention, the light beam "L” comprises lighted areas and dark areas. Particularly, the portions that have been filled with the first color in the processed image correspond to the lighted areas of the light beam “L”. Likewise, the portions that have been filled with the second color in the processed image correspond to the dark areas of the light beam “L”. Thus, advantageously, the image projection device (4) illuminates the interior of the edges (B) of the previously identified shapes (F). It shall be noted that, in the preferred embodiment of the invention, the light beam "L" generated by the image projection devices 4 reproduces the image produced on the area "A", thereby illuminating the objects therein and leaving the empty parts in the area "A” dark.

Optionally, the image projection devices 4 is configured to detect its distance from the area "A", particularly with respect to each shape "F" identified in the captured image. The image projection device 4 is designed to adjust the illuminance of the light beam generated according to the detected distance. As used herein, the term illuminance is intended as the ratio of the luminous flux on an surface element to the area of the element. The term luminous flux is intended as the product of the luminous intensity of the light source by the solid angle of the light beam.

Optionally, the image projection device 4 is configured to adjust the illuminance of the light beam “L” generated in response to the detected texture if this information is available in the second signal “EL”.

A method for illuminating objects arranged in the area “A” is described below.

Particularly, the method is described in its application to the above discussed apparatus 1. In certain alternative embodiments, which form part of the present invention, the method may also be carried out without using the apparatus 1.

In an optional initialization step, the area "A" is uniformly illuminated, with a white rectangle projected over the entire area "A". Advantageously, this affords a more accurate recognition of the edges "B".

More in detail, during the initialization step the processing unit 3, and particularly the control module 7, generate a rectangular background image having a uniform white color. This background image is encoded in the second signal "EL", which is sent to the image projection device 4, which projects it on the area "A", thereby generating a uniform light beam "L", corresponding to the received image.

Now the projected image may be detected, particularly through the imaging device 2. Advantageously, the perspective distortion caused by the angle of incidence of the light beam "L" on the area "A" may be corrected.

In a first step, an image in the area "A" is captured, with the purpose of detecting the shapes "F". This operation is preferably carried out by the imaging device 2, which sends the aforementioned first signal "IM" to the processing unit 3, particularly to the acquisition module 5.

If the initialization step has been carried out, the imaging device 2 captures the image in the area "A" while it is being illuminated by the uniform light beam "L".

Then, the digitized image is processed using an image recognition and edge detection algorithm. The shapes "F" with their respective edges "B" are so defined. Preferably, this operation is carried out by the processing unit 3, particularly the recognition module 6.

Then, the first color is uniformly applied inside the edge "B" of each identified

shape “F”. At the same time, the second color is uniformly applied outside the edges "B". This operation is particularly carried out by the processing unit 3, more particularly by the control module 7, which generates the aforementioned second signal "EL".

Then, a light beam “L” representative of the processed image is generated. This light beam "L" is directed to the area "A", to illuminate it. This operation is preferably carried out by the image projection device 4.

Optionally, the method comprises a step of detecting the distance between the light source, preferably the image projection device 4, and each identified shape "F". Based on such distance, the illuminance of the generated light beam "L" may be adjusted.

Optionally, the texture of the zones inside the edges "B" of the identified shapes "F" may be detected, particularly to detect the type of surface to be illuminated. Thus, the illuminance of the light beam “L” may be adjusted in response to the detected texture.

Those skilled in the art will obviously appreciate that a number of changes and variants as described above may be made to fulfill particular requirements, without departure from the scope of the invention, as defined in the following claims.

CLAIMS

1. An apparatus (1) for illuminating objects in an area (A), said apparatus comprising:

- an imaging device (2) configured to capture an image of said area (A) and generate a first signal (IM) representative of said captured image,

- a processing unit (3) in signal communication with said imaging device (2) and configured to:

- receive said first signal (IM),

- process said first signal (IM) by an image recognition and edge detection algorithm to identify one or more shapes (F) bounded by edges (B) in said acquired image, and

- process said acquired image by uniformly filling each identified shape (F) with a first color, and uniformly filling the parts of said acquired image external to said edges (B) with a second color to generate a second signal (EL) representative of the processed image,

- an image projection device (4) in signal communication with said imaging unit (3) and configured to:

- receive said second signal (EL), and

- generate a light beam (L) representative of the processed image,

- directing said light beam (L) to said area (A).

2. An apparatus (1) as claimed in claim 1, wherein:

- said light beam (L) comprises light areas and dark areas,

- the portions with said first color in the processed image correspond to said light areas of said light beam (L),

- the portions with said second color in the processed image correspond to said dark areas of said light beam (L),

whereby said image projection device (4) illuminates the inside of the edges (B) of the shapes (F) so identified.

3. An apparatus as claimed claim 1 or 2, wherein

- said first color is white and said second color is black.

4. An apparatus as claimed in any of claims 1 to 3, wherein:

- said imaging device (4) is actuated to capture said image of said area (A) under uniform illumination of said area (A):

5. An apparatus as claimed in claim 4, wherein, in order to capture said image in said area (A) under uniform illumination of said area (A),

- said processing unit (3) is configured to create a uniform image of a rectangular white background,

- said image projection device (4) is configured to generate a uniform light beam (L) representative of said background image and direct the uniform light beam (L) on said area (A),

- said imaging device (2) is configured to capture the image of said area (A) under uniform illumination of said area (A) by means of said uniform light beam.

6. An apparatus as claimed in any of claims 1 to 5, wherein:

- the light beam generated by said image projection device (4) reproduces the processed image on said area (A).

7. An apparatus as claimed in any of claims 1 to 6, wherein:

- said image projection device (4) is configured to:

- detecting the distance between said image projection device (4) and each shape (F) identified in said captured image,

- adjusting the illumination of the light beam (L) generated as a function of the detected distance.

8. An apparatus as claimed in any of claims 1 to 7, wherein:

- said processing unit (3) is also configured to process said first signal (IM) to detect the texture of the areas inside the edges (B) of the identified shapes (F), said second signal (EL) comprising information representative of said detected texture,

- said image projection device (4) is configured to adjust the illumination of the light beam generated according to the detected texture.

9. An apparatus as claimed in any of claims 1 to 8, wherein said processing unit (3) is configured to process images by means of the Canny algorithm.

10. A method of illuminating objects in an area, said method comprising the steps of:

- capturing an image of an area (A);

- processing said captured image by an image recognition and edge detection algorithm to identify one or more shapes (F) bounded by edges (B);

- uniformly filling each identified shape (F) with a first color, and uniformly filling the parts of said captured image external to said edges (B) with a second color to generate a processed image,
- generating a light beam (L) representative of the processed image,
- directing said light beam (L) to said area (A).

11. A method as claimed in claim 10, wherein:
- said light beam (L) comprises light areas and dark areas,
- the portions with said first color in the processed image correspond to said light areas of said light beam,
- the portions with said second color in the processed image correspond to said dark areas of said light beam.

12. A method as claimed in claim 10 or 11, wherein
- said first color is white and said second color is black.

13. A method as claimed in any of claims 10 to 12, wherein:
- said step of acquiring an image of said area comprises an initialization step, that is carried out under uniform illumination of said area (A).

14. A method as claimed in claim 13, wherein said initialization step comprises the steps of:
- creating a uniform image of a rectangular white background,
- generating a uniform light beam (L) representative of said background image,
- directing the uniform light beam (L) to said area (A),

- capturing the image of said area (A).

15. A method as claimed in any of claims 10 to 14, wherein:

- said step of generating a light beam (L) causes the reproduction of said processed image on said area (A).

16. A method as claimed in any of claims 10 to 15, wherein said step of generating a light beam (L) comprises the step of:

- detecting the distance between a source (4) of said light beam and each shape (F) identified in said captured image,

- adjusting the illumination of the light beam (L) generated as a function of the detected distance.

17. A method as claimed in any of claims 10 to 16, wherein:

- said step of processing said image comprises the step of detecting the texture of the areas inside the edges (B) of the shapes (F) so identified,

- said step of generating a light beam (L) comprises the step of adjusting the illumination of the light beam (L) so generated according to the detected texture.

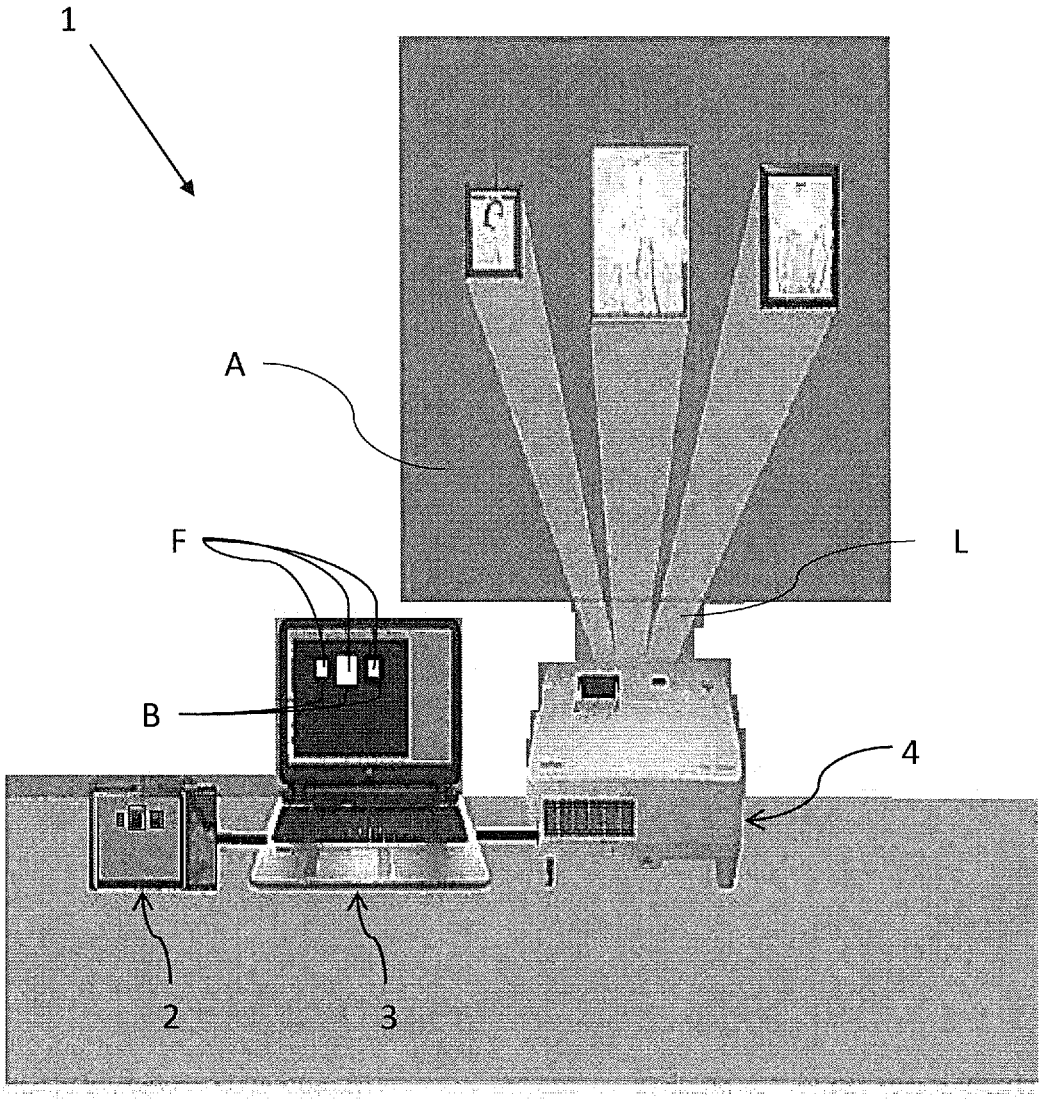

Fig. 1

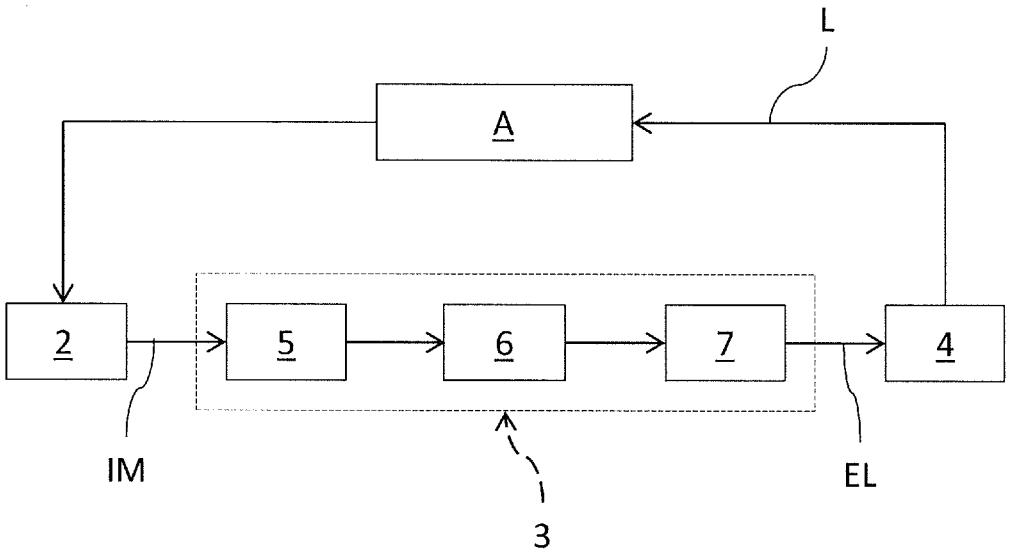

Fig. 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2018/055619

A. CLASSIFICATION OF SUBJECT MATTER
INV. H05B37/02 H05B33/08 H04N5/225 G06T1/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H05B G06T H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 2 364 013 A2 (SONY CORP [JP]) 7 September 2011 (2011-09-07) page 4, paragraph 21 - page 7, paragraph 50; figures 1-6, 8-11, 13, 14, 15	1-17
X	WO 2013/138148 A1 (DOLBY LAB LICENSING CORP [US]) 19 September 2013 (2013-09-19) the whole document	1-17
X	WO 2014/009277 A1 (ELECTROLUX AB [SE]) 16 January 2014 (2014-01-16) the whole document	1-17
A	US 2011/115910 A1 (BRACKNEY LARRY J [US]) 19 May 2011 (2011-05-19) paragraph [0036] - paragraph [0037]	9

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 October 2018	15/10/2018

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Burchielli, M

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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